Protection of Lithium Ion Batteries (three cells in series)
Monolithic IC MM1293

Outline

This IC provides protection for lithium ion batteries in the event of overcharging, overdischarging and overcurrents. When anomalies occur during charging or at other times and excessive voltages are applied, after a certain time has elapsed for each cell an external FET switch is turned off (overcharging detection) ; and in order to prevent overdischarge of the battery during discharge, when the voltage of individual batteries falls below a fixed voltage, an external FET switch is turned off (overdischarging detection), and the IC is put into low-consumption current mode. When large currents flow due to a short-circuit or other cause, an external MOS switch is turned off (overcurrent detection).

3-Cell Protection ICs

Rank	Overcharge detection voltage	Overcharge hysteresis voltage	Overdischarge detection voltage	Overdischarge resume voltage	Overcurrent detection voltage	At overcurrent detection	Overcurrent release conditions
A	4.35V±50mV	200mV typ.	2.35V typ.	3.05V typ.	150mV typ.	Pin 3 (DOHG pin) L→H	Load release 250kΩ or more
B	4.25V±50mV	↓	2.40V typ.	3.10V typ.	↓	↓	↓
C	Same as rank A	↓	Same as rank A		↓	Pin 4 (OL pin) H→L	↓
D	Same as rank B	↓	Same as rank B		↓	↓	↓
E	↓	none (several mV)	Same as rank B		↓	Pin 3 (DOHG pin) L→H	↓
F	4.10V±50mV	↓	2.35V typ.	3.00V typ.	↓	↓	↓
G	Same as rank A	200mV typ.	Same as rank A		↓	↓	Charging reset

Features

1.	Current consumption (overcharging)	$V_{CELL} > V_{CELLU}$	125μA typ.
2.	Current consumption (normal operation)	$V_{CELL} < V_{ALM}$	30μA typ.
3.	Current consumption (overdischarge)	$V_{CELL} < V_{CELLS}$	0.1μA max.
4.	Overcharge detection voltage (−20 to +70°C)	V_{CELL} : L→H	4.25V±50mV/CELL
5.	Overcharge hystereis voltage	V_{CELL} : H→L	V_{CELLU}−200mV/CELL typ.
6.	Overcharge sensing dead time	C=0.1μF	1.0S typ.
7.	Overcharge sensing operation voltage	V_{CELL} : L→H	4.10V±150mV/CELL
8.	Overdischarge detection voltage	V_{CELL} : H→L	2.40V/CELL typ.
9.	Overdischarge sensing dead time	C=0.1μF	1.0S typ.
10.	Overcurrent detection voltage		0.15V typ.

11. Overcharge and overdischarve voltages as well as the overcurrent detection voltage can be changed upon request.

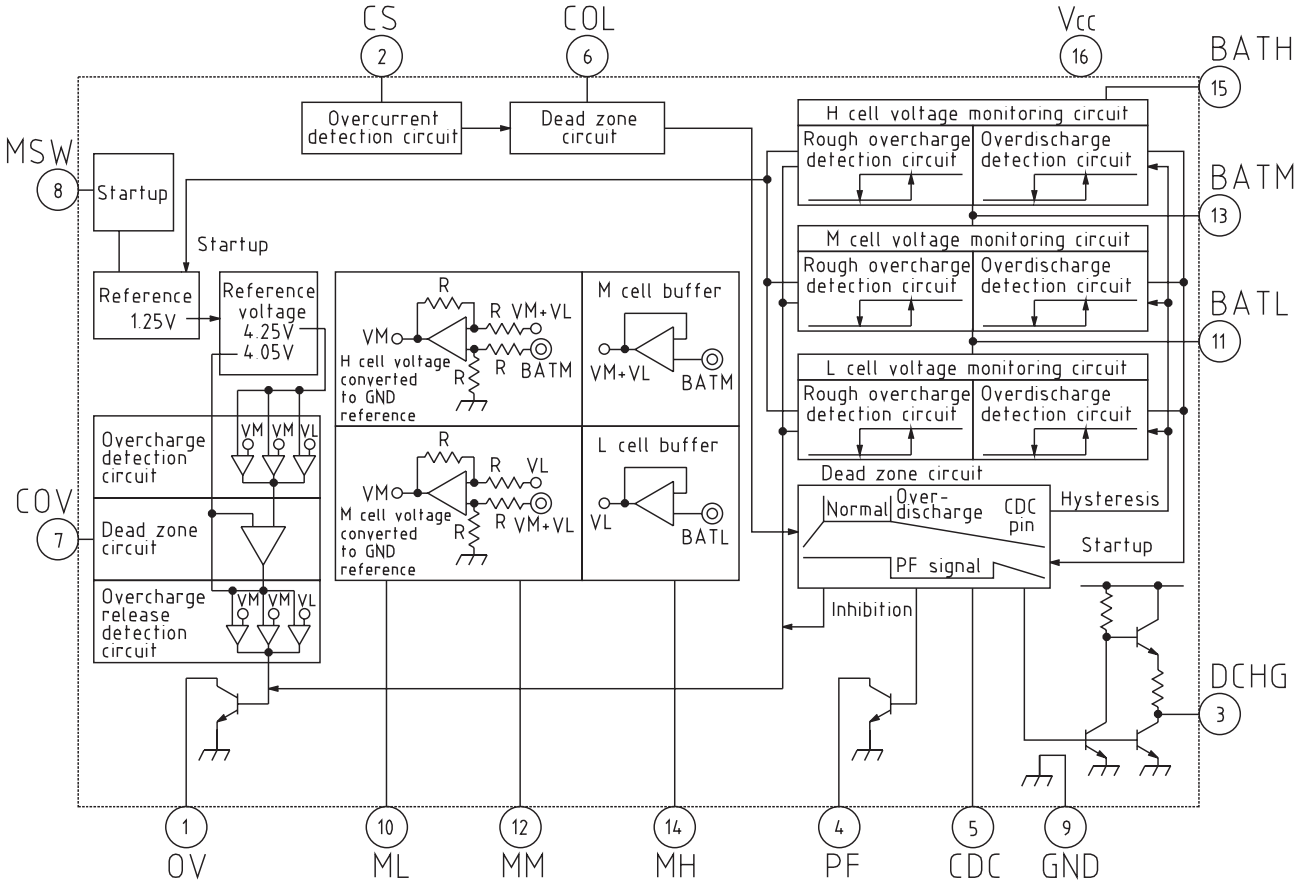
Package

SSOP-16

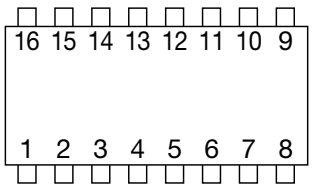
Applications

Lithium ion battery pack for notebook computers

Block Diagram



Pin Assignment



SSOP-16

1	OV	9	GND
2	CS	10	ML
3	DCHG	11	BATL
4	PF	12	MM
5	CDC	13	BATM
6	COL	14	MH
7	COV	15	BATH
8	MSW	16	Vcc

Pin Assignment

Pin no.	Pin name	Input/output	Function
1	OV	Output	Overcharge detection output pin NPN transistor open collector output; normally high impedance, goes to L level on overdischarge
2	CS	Input	Overcurrent detection pin Monitors equivalent load current through source-drain voltage drop of discharge-controlling FET, and at or above the overcurrent detection voltage sets the DCHG pin to "H" and turns off the discharge-controlling FET. Following overcurrent detection, current is passed from this pin, and if the load is decreased, the overcurrent mode is canceled. Through this action there is a temporary consumption current (at the V_{CC} pin) of approx. 1 mA on resumption of discharge and detection of overdischarge. This function is disabled in overdischarge mode.
3	DCHG	Output	Pin driving the discharge-controlling FET (P-ch) Normally "L"; on overdischarge set to "H" Output pin for overdischarge detection signals
4	PF	Output	Overdischarge detection pin When the overdischarge detector detects overdischarge at the open collector output of the NPN transistor, this pin is turned on. A delay is provided by setting a dead time until discharge ends, so that by utilizing a reset or other signal from a CPU or some other controlling device, the equipment can be put into standby mode.
5	CDC	Input	Pin to set the dead time for overdischarge detection By connecting a capacitor between the CDC pin and GND, a dead time can be set. Pin to set the dead time for overcurrent detection
6	COL	Input	Pin to set the dead time for overcurrent detection By connecting a capacitor between the COL pin and GND, a dead time can be set. If NC, protection is triggered in a short amount of time; the dead time should be set according to the application.
7	COV	Input	Pin to set the dead time for overcharge detection By connecting a capacitor between the COV pin and GND, a dead time can be set.
8	MSW	Input	Pin to switch the cell voltage monitor on/off GND: monitor on, V_{CC}: monitor off The cell voltage monitor converts the different cell voltages to a GND-reference voltage and outputs it from the ML, MM and MH pins.
9	GND	Input	Ground pin
10	ML	Output	Monitor output pin for the L cell voltage
11	BATL	Input	Pin for input of L cell high-side voltage and M cell low-side voltage
12	MM	Output	Monitor output pin for the M cell voltage
13	BATM	Input	Pin for input of M cell high-side voltage and H cell low-side voltage
14	MH	Output	Monitor output pin for the H cell voltage
15	BATH	Input	Pin for input of H cell high-side voltage
16	V_{CC}	Input	Power supply input pin The same potential as the BATH pin should be input

Absolute Maximun Ratings (Ta=25°C)

Item	Symbol	Ratings	Units
Storage temperature	T_{STG}	–40~+125	°C
Operating temperature	T_{OPR}	–20~+70	°C
Charge voltage	V_{BAT} max.	18	V
Power supply voltage	V_{CC} max.	18	V
Voltage applied to OV pin	V_{OV} max.	18	V
Allowable loss	Pd	300	mW

Recommended Operating Conditions

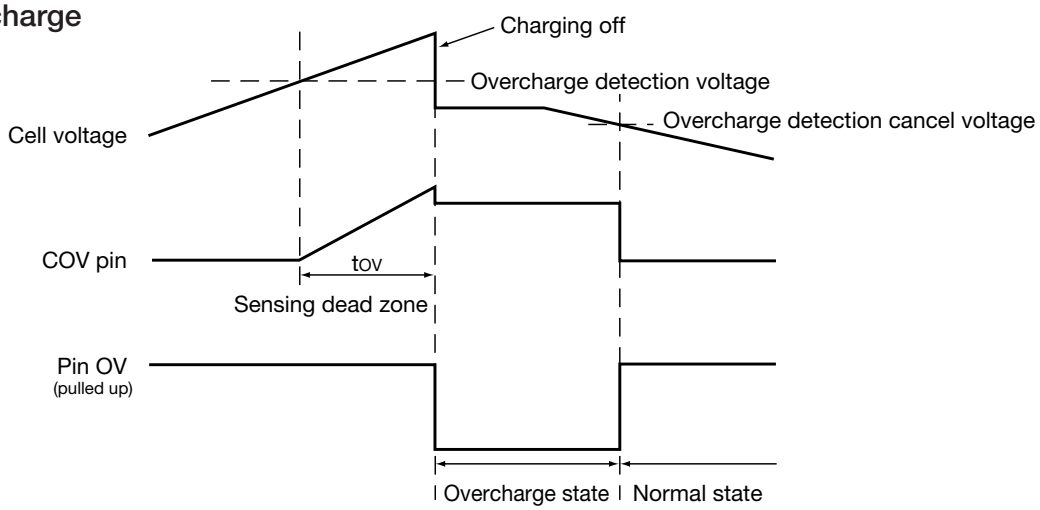
Item	Symbol	Ratings	Units
Operating temperature	T_{OPR}	−20~+70	°C
Operating voltage	V_{OPR}	+2~+18	V

Electrical Characteristics (Except where noted otherwise, Ta=25°C, V_{CC}=15V, V_{CELL}=V_{BATH}=V_{BATM}=V_{BATL})

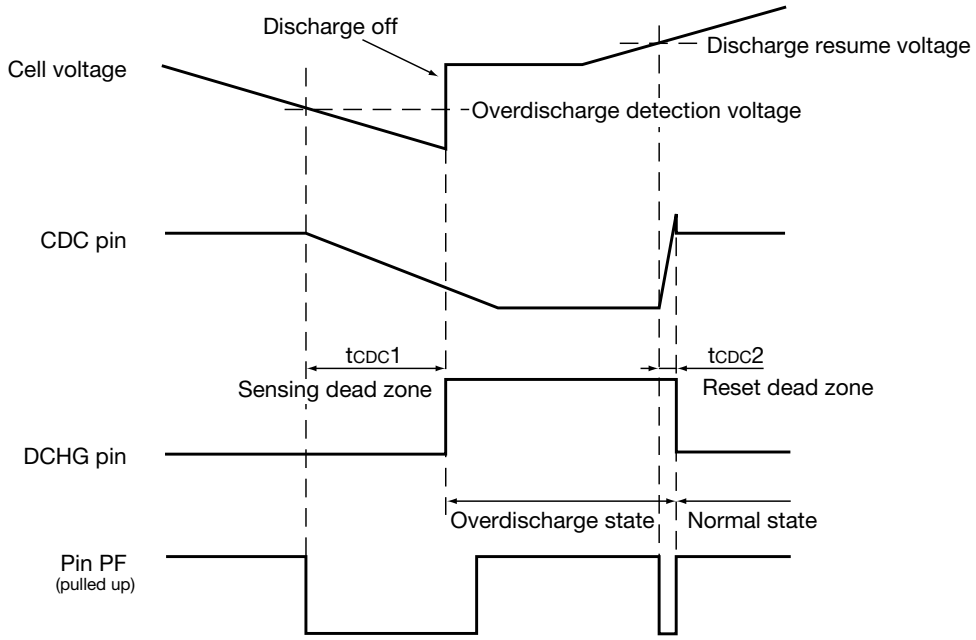
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current (V_{CC} pin) 1	$I_{CC}1$	V_{CELL}=4.4V		125	250	µA
Consumption current (V_{CC} pin) 2	$I_{CC}2$	V_{CELL}=3.5V		30	60	µA
Consumption current (V_{CC} pin) 3	$I_{CC}3$	V_{CELL}=2.2V			0.1	µA
Consumption current (BATH pin) 1	$I_{BATH}1$	V_{CELL}=4.4V		11	22	µA
Consumption current (BATH pin) 2	$I_{BATH}2$	V_{CELL}=3.5V		5	10	µA
Consumption current (BATH pin) 3	$I_{BATH}3$	V_{CELL}=2.2V		2	4	µA
BATM pin input current 1	I_{BATM}	V_{CELL}=3.5V			±300	nA
BATM pin input current 2	I_{BATMA}	V_{CELL}=4.4V	−0.6	−0.3	0	µA
BATL pin input current 1	I_{BATL}	V_{CELL}=3.5V			±300	nA
BATL pin input current 2	I_{BATLA}	V_{CELL}=4.4V	−0.6	−0.3	0	µA
Overcharge detection voltage	V_{CELLU}	Ta=−20~+70°C, V_{CELL} : 3.7V→4.5V	4.20	4.25	4.30	V
Overcharge detection release voltage	V_{CELLO}	V_{CELL} : 4.5V→3.7V	V_{CELLU} −260mV	V_{CELLU} −200mV	V_{CELLU} −140mV	V
Overcharge sensing dead time	t_{OV}	C_{OV}=0.1µF	0.5	1.0	1.5	S
Overcharge sensing operation voltage	V_{ALM}	V_{CELL} : 3.5V→4.4V	3.95	4.10	4.25	V
Overdischarge sensing hysteresis voltage	$\triangle V_{ALM}$	V_{CELL} : 4.4V→3.5V	120	200	300	mV
Overdischarge detection voltage	V_{CELLS}	V_{CELL} : 3.5V→2.0V	2.30	2.40	2.50	V
Discharge resume voltage	V_{CELLD}	V_{CELL} : 2.0V→3.5V	2.95	3.10	3.25	V
Overdischarge sensing hysteresis voltage	$\triangle V_{CSD}$	V_{CELLD}−V_{CELLS}	490	700	910	mV
Overdischarge sensing dead time	$t_{CDC}1$	C_{CDC}=0.1µF	0.5	1.0	1.5	S
Overdischarge reset dead time	$t_{CDC}2$	C_{CDC}=0.1µF, V_{CS}=V_{CC}+0.3V		7		mS
Overcurrent detection voltage	V_{OC}	V_{CC}−V_{CS}, D_{CHG}	0.135	0.150	0.165	V
Overcurrent sensing dead time	$t_{COL}1$	C_{COL}=0.001µF, D_{CHG}	5	10	15	mS
Overcurrent reset dead time	$t_{COL}2$	C_{COL}=0.001µF, D_{CHG}	5	10	15	mS
Overcurrent sensing delay time	$t_{COL}3$	C_{COL}=0, D_{CHG}		150		µS
Overcurrent reset delay time	$t_{COL}4$	C_{COL}=0, D_{CHG}		150		µS
Overcurrent protection release			Open-load condition 250kΩ			
DCHG pin source current	$I_{SO}D_{CH}$	V_{CELL} < V_{CELLS}, SW1 : A, V_{DCHG}=V_{CC}−1.8V	20			µA
DCHG pin sync current	$I_{SI}D_{CH}$	V_{CELL} > V_{CELLS}, SW1 : A, V_{DCHG}=0.8V	20			µA
DCHG pin output voltage H	$V_{TH}D_{CH}$	V_{CC}−V_{DCHG}, I_{SO}=20µA, SW1 : B			1.8	V
DCHG pin output voltage L	$V_{TH}D_{CL}$	V_{DCHG}−GND, I_{SI}=−20µA, SW1 : B			0.8	V
OV pin sync current	$I_{SI}O_V$	V_{OV}=0.4V, Ta=−20~+70°C	0.2			mA
PF pin sync current	$I_{SI}P_F$	V_{PF}=0.4V, Ta=−20~+70°C	10			µA

Timing Chart

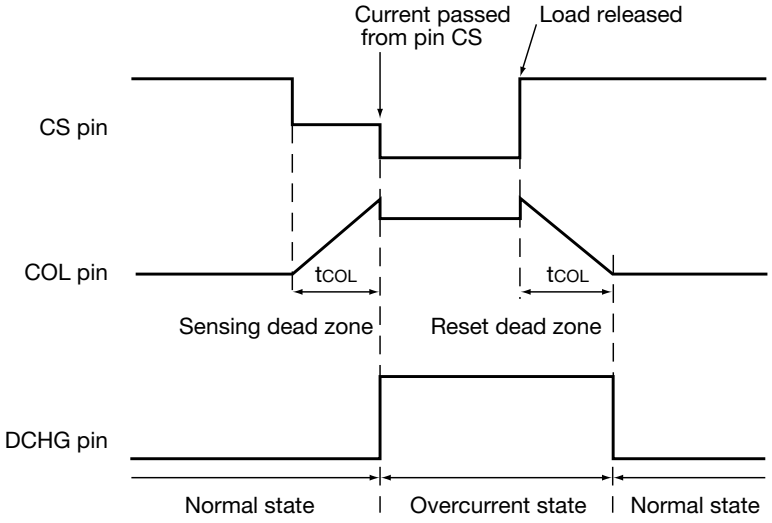
Overcharge



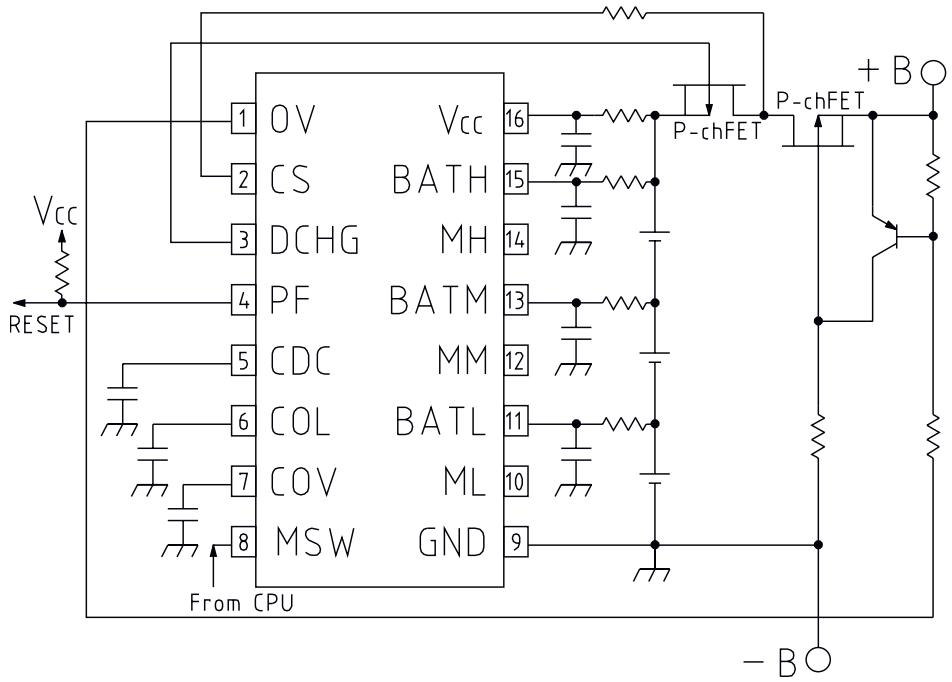
Overdischarge



Overcurrent

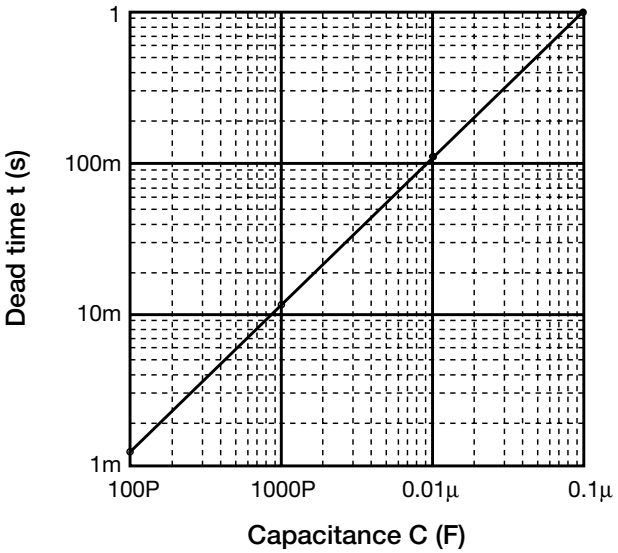


Application circuits

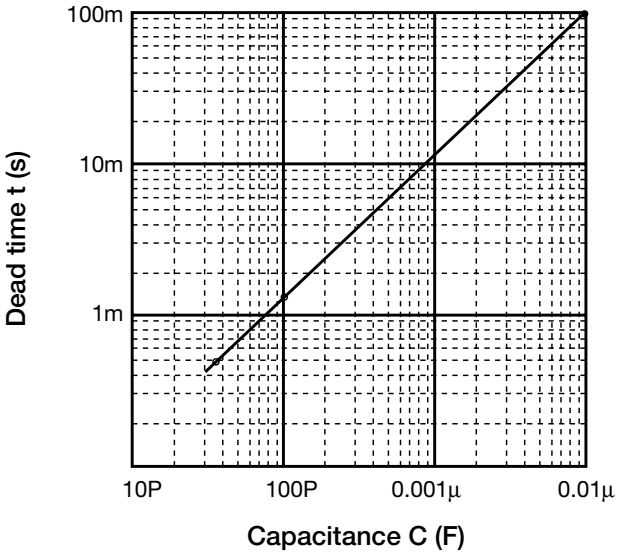


Characteristics

Overcharge, overdischarge sensing dead time



Overcurrent dead time



Note : The above characteristics are representative and are not guaranteed.